

REVIEW AND FURTHER DESCRIPTIONS OF EGGS AND FEMALES OF THE NORTH AMERICAN STONEFLY GENUS *SETVENA* (PLECOPTERA: PERLODIDAE)¹

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ABSTRACT: Eggs and females of the three western North American *Setvena* species are comparatively described, illustrated, and a key provided.

The generic assignment of North American *Setvena* species within the family Perlodidae was problematic until Ricker's (1952) introduction of the name, without type designation, as a subgenus of *Arcynopteryx*. He included the Pacific Northwest species *Setvena tibialis* (Banks) and the Rocky Mountain species *S. bradleyi* (Smith), based on their unique genitalia and submental-thoracic gill characteristics. They represent the only genus within the subfamily Perlodinae having the combination of a pair of simple, fingerlike gills (nymphs) or gill remnants (adults) arising from the submentum, and anteromesally on the meso- and metathorax (Ricker 1952, Shepard & Stewart 1983, Stewart & Stanger 1985, Stewart & Stark 1988). Both species had been assigned to Klapálek's (1912) Oriental genus *Protarcys* by Smith (1917) and Hanson (1942), and *S. tibialis* had been included in the genus *Perlodes* by Banks (1914), Needham & Claassen (1925), Claassen (1931), and Frison (1942). Male and female genitalia of both species have been variously described and illustrated by Banks (1914), Smith (1917), Needham & Claassen (1925), Frison (1942) and Hanson (1942). *Setvena* was given full generic status, with *Protarcys bradleyi* designated as type, by Illies (1966).

A third species, *Setvena wahkeena*, currently known only from the Columbia River Gorge near Portland, Oregon, was described by Stewart & Stanger (1985); they illustrated the male genitalia and comparatively described, illustrated and keyed the male epiprocts and stylets, and nymphs of all three *Setvena* species. These stoneflies are important insect predators and food web components in small streams in their respective western North American ranges.

Stark & Szczytko (1988) illustrated the chorionic follicle cell impressions and micropyles of *S. bradleyi* and *S. tibialis* eggs, and an oblique polar view of the *S. wahkeena* egg, without comparative written descriptions of diagnostic characters of the three species; they also illustrated the male epiproct complex, hemiterga and lateral stylet apex of *S. wahkeena*. The female of *S. wahkeena* has remained undescribed.

We undertook this study to describe the female of *S. wahkeena*, and pro-

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vide comparative descriptions and illustrations for the eggs and females of all three *Setvena* species. These, with previous descriptions, will allow the determination of all *Setvena* species from all life stages and provide additional morphological character states for future phylogenetic analysis and inference for the large and ecologically important family Perlodidae.

MATERIALS AND METHODS

We began collecting and rearing nymphs of *Setvena* in 1979, as part of our larger study of nymphs of North American Plecoptera genera (Stewart & Stark 1988). These rearings and field associations by us and colleagues have yielded study specimens of all life stages outlined by Stewart & Stanger (1985), Stark & Szczytko (1988), and further material for this study. The female subgenital plates were drawn with aid of a wild M-5A stereomicroscope with drawing attachment. Eggs were extracted from females, prepared and photographed by SEM as follows:

Eggs were cleaned in an ultrasonicator, dehydrated in acetone and mounted on specimen stubs with silver paint. Specimens were sputter coated with gold-palladium and examined with an AMRAY 1810-D scanning electron microscope. Specimens used in this study are deposited in the collections of B. P. Stark, Mississippi (BPS), Colorado State University, Fort Collins, Colorado (CSU) and K. W. Stewart, Denton, Texas (KWS).

Material examined: *S. bradleyi*: BRITISH COLUMBIA, head of Gwillim Creek on Gadsheim Massif, 22-31-VII-1958, 6 ♀, John Ricker (KWS); MONTANA, Lake Co., Boulder Creek, east shore Flathead Lake, 21-VI-1985, 3 ♀, 1 ♂ all reared, K.W. Stewart (KWS); same locality, 23-VI-1987, 1 ♀ reared, K.W. Stewart (KWS); same locality, 6-VII-1987, 1 ♀ reared, K.W. Stewart, B. Poulton, (KWS). *S. tibialis*: WASHINGTON, Whatcom Co., seeps on George Lake, Hwy 20, 10-VI-1991, 1 ♀ reared, B. Stark, R. W. Baumann, C. Henderson, (BPS); Pierce Co., Paradise Ice Caves, Mt. Rainier N.P., 20-VIII-1995, 2 ♀ reared, R. Lechleitner (CSU); Pierce Co., Mowich Rd at Grindstone trail crossing, Mt. Rainier N.P., 17-VII-1995, 1 ♀, E.E. Lisowski (CSU); Pierce Co., St. Andrews Creek, Westside Road, 24-VII-1997, 1 ♀, R. Lechleitner (CSU). *S. wahkeena*: OREGON, Multnomah Co., Wahkeena Falls, 23-VI-1985, K.W. Stewart (KWS); same location, 30-VI-1957, 1 ♀, S.G. Jewett (BPS); same location, 25-VI-1985, B. Stark (BPS).

RESULTS AND DISCUSSION

Egg Descriptions

Setvena bradleyi (Smith)

Egg.- Figs. 1A, B. Length about 0.48 mm, diameter about 0.36 mm. Chorion covered with hexagonal follicle cell impressions except area surrounding collar. Follicle cell impression walls thin and slightly elevated above granular floor; impressions more conspicuous on posterior pole than near collar. Collar sessile, area surrounding collar coarsely granular. Micropyles surrounded by obscure rosettes of follicle cell impressions; sperm guides short and linear.

Setvena tibialis (Banks)

Egg.- Figs. 1C - E. Length about 0.5 mm, diameter about 0.34 mm. Chorion covered with hexagonal follicle cell impressions except area surrounding collar. Follicle cell impressions relatively uniform throughout with walls thin and slightly raised above granular floor. Collar sessile,

area surrounding collar smooth; anchor mushroom shaped. Micropyles with smooth elevated orifices surrounded by obscure rosettes of follicle cell impressions.

Setvena wahkeena Stewart & Stanger

Egg.- Fig. 1F. Length about 0.45 mm, diameter about 0.36 mm. Chorion covered with obscure hexagonal follicle cell impressions, almost appearing smooth. Follicle cell impression walls formed by shallow trenches, floors smooth and slightly elevated above walls. Collar reduced to an obscure button without surrounding area of modified chorion. Micropyles with sessile orifices and without distinct surface sperm guides.

Female Descriptions

Setvena bradleyi (Smith)

Previous descriptions: (1) Smith (1917; line drawing of subgenital plate [as *Protarcys bradleyi*]), (2) Needham & Claassen (1925; wing of adult and line drawing of an incorrect broadly rounded subgenital plate [as *Perlodes bradleyi*]); these authors noted that the figures on their plate 9 were taken from Smith (1917), (3) Frison (1942; figure of subgenital plate [incorrectly as *Perlodes tibialis*] that conforms to our reared *S. bradleyi*), (4) Hanson (1942; simple outline of abdominal segments 7-9 [as *Protarcys bradleyi*], showing subgenital plate shape and plate correctly extending about halfway over segment 9), (5) Baumann et al. (1977; terminal abdominal segments with subgenital plate outline depicted correctly).

These figures, some incorrectly assigned to species and with setation and sclerotization shown rather generically, if at all, have pointed up the need for comparative study of reared females correlated with males.

Subgenital plate (Fig. 2A): broadly triangular, base about 0.7 times width of 8th sternum, apex unnotched, extending posteriorly over about one half of 9th sternum, surface smooth with a few short hairs over apical marginal surface.

Setvena tibialis (Banks)

Previous descriptions: (1) Smith (1917; Fig. 39 line drawing of subgenital plate [as *Protarcys dolobrata*] showing correctly a shallowly notched apex), (2) Needham & Claassen (1925; line drawing of subgenital plate, not apparently *S. tibialis* [as *Perlodes dolobrata*, incorrectly copied from Smith's more accurate figure] showing unnotched, broadly rounded plate extending past apex of 9th sternum; on p. 54, Needham & Claassen indicated that the female of *Perlodes tibialis* was unknown), (3) Hanson (1942; simple outline of abdominal segments 7-9 [as *Protarcys tibialis*], showing unnotched subgenital plate shape and plate correctly extending near or to posterior margin of segment 9), (4) Frison (1942; figure 58 [as *Protarcys tibialis* is actually *S. bradleyi*]).

As in *S. bradleyi*, the generic nature of illustrations, some incorrectly assigned to species, have led to confusion of females.

Subgenital plate (Figs. 2B, C): broadly saggitate with convex, free apical margins, base about 0.6 times width of 8th sternum, apex shallowly notched, extending posteriorly over about 0.9 of the 9th sternum, surface faintly, transversely striated with evenly distributed short hairs.

Setvena wahkeena Stewart & Stanger

Previous descriptions: none.

Subgenital plate: (Fig. 2D): triangular, base about 0.55 times width of 8th sternum, apex shallowly notched, extending posteriorly over about 0.4-0.5 of 9th sternum, surface faintly, transversely striated with a few short hairs restricted to apical margins.

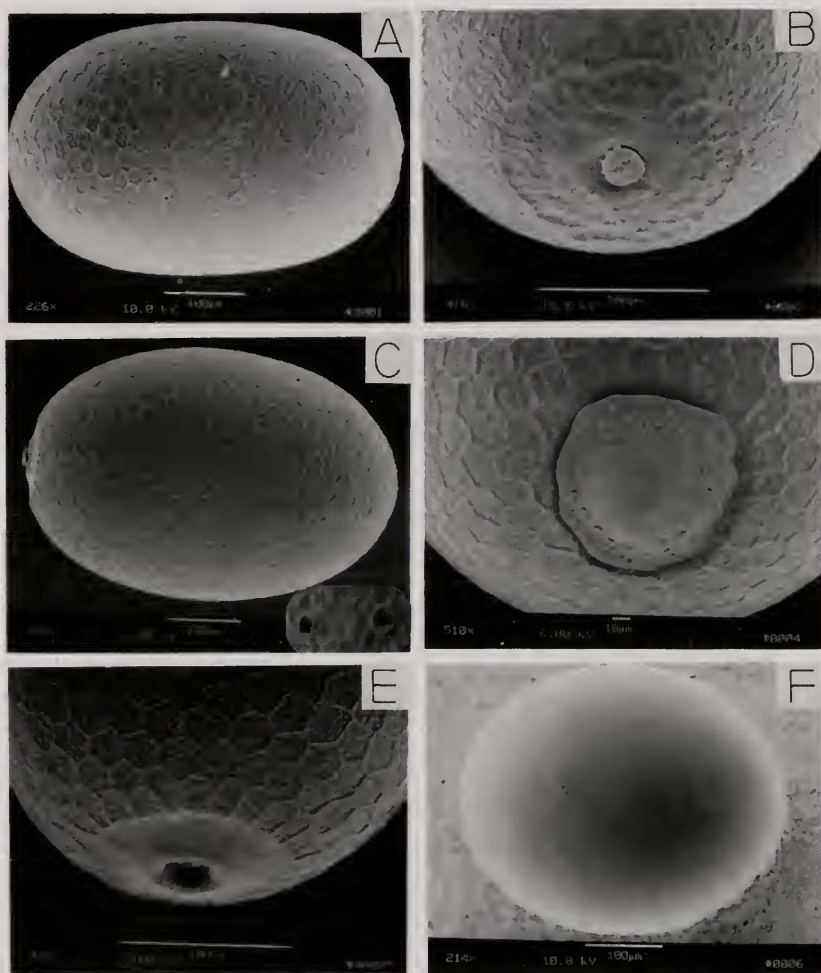


Fig. 1. *Setvena* eggs: A., *S. bradleyi* egg, British Columbia; B., *S. bradleyi* egg collar, Mt. Rainier N.P., Washington; C., *S. tibialis* egg, Mt. Rainier N.P., Washington (inset micropyles at 1,000x); D., *S. tibialis* egg anchor, Mt. Rainier N.P., Washington; E., *S. tibialis* egg collar, Mt. Rainier N.P., Washington; F., *S. wahkeena* egg, Wahkeena Falls, Multnomah Co., Oregon.

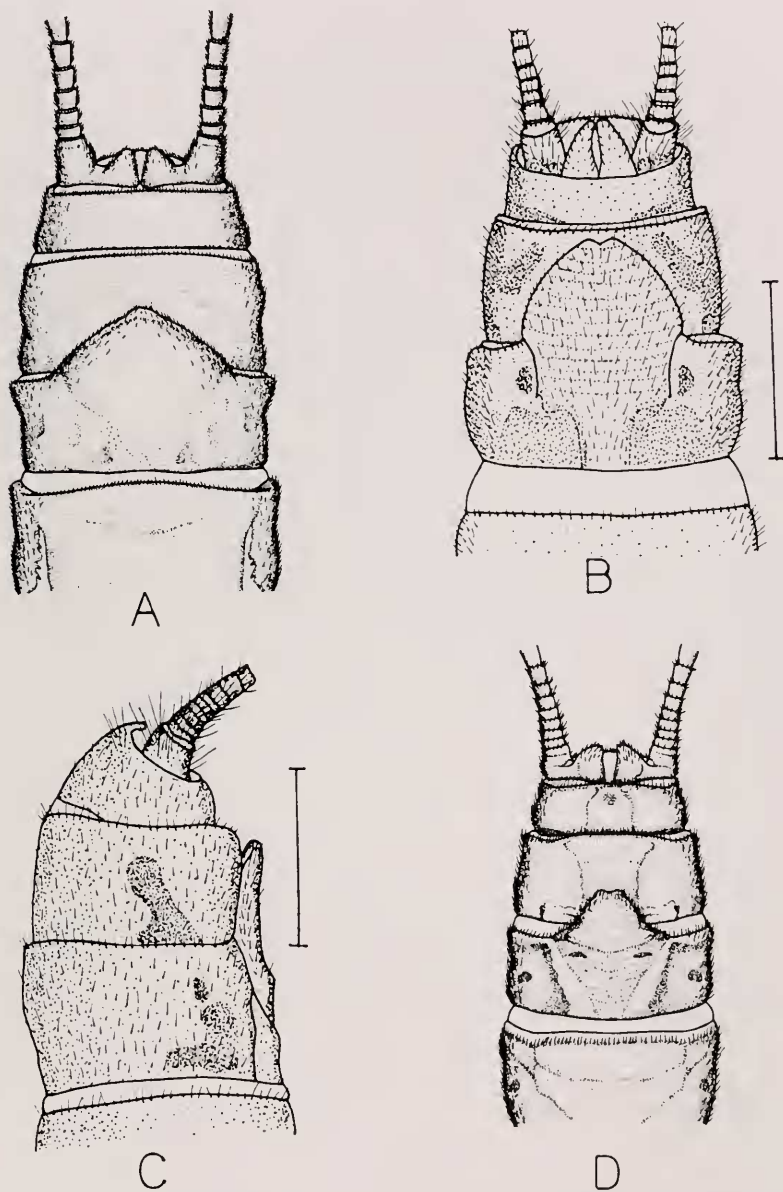


Fig. 2. *Setvena* female subgenital plates: A., *S. bradleyi*, ventral; B., *S. tibialis*, ventral, scale line = 2 mm; C., *S. tibialis*, left side view, scale line = 2 mm; D., *S. wahkeena*, ventral.

DISCUSSION

The distinct subgenital plates of reared *S. bradleyi* (Fig. 2A) and *S. tibialis* (Figs. 2B, C) resolve past confusion of females of these two species, including the incorrect correlation and illustration by Frison (1942) of a female *S. bradleyi* (as *Perlodes tibialis*) with a male *S. tibialis* (as *Perlodes tibialis*). Frison believed these two specimens were of opposite sex *S. tibialis* because both were collected from Fish Lake, British Columbia, and the female agreed with the male in gill arrangement. This is a classic example of how sexes of different congener species of cohabiting sympatric populations can be confused. In this case, *S. bradleyi* is typically distributed in the Rocky Mountains, and *S. tibialis* in the Pacific Northwest, with both known to overlap only in British Columbia. This further points up the need for diagnosis of females of other multispecific perlodid genera such as *Cultus*, *Isogenoides*, and *Isoperla* from reared females correlated with conspecific males. Such data, along with complete egg descriptions from correctly identified females, will provide a wealth of additional characters for future phylogenetic analyses.

Presently we have identified a few characters selected from nymphal setation, male genitalia and egg morphology with potential value for phylogenetic analysis of *Setvena* species. Unfortunately, many of these are autapomorphies for one species and only two apomorphic characters, the sessile egg collar with surrounding anchor impression, shared by *S. bradleyi* and *S. tibialis*, and the coarsely serrate stylet tips shared by *S. wahkeena* and *S. tibialis* appear useful. Because these characters suggest different relationships among the three species, we will defer further speculation until more characters are available.

We offer the following key for separation of *Setvena* females and eggs. Males are separated by key characters given by Stewart and Stanger (1985).

1. Subgenital plate extends over about 0.9 of sternum 9 length (Fig. 2B); modified area around egg collar smooth (Fig. 1E) *S. tibialis*
 Subgenital plate extends over about 0.5-0.6 of sternum 9 length (Figs. 2A, 2D); collar without modified surrounding area, or surrounding area with rough surface (Fig. 1B) 2
2. Apex of subgenital plate truncate or emarginate, narrowly triangulate (Fig. 2D); egg almost spherical with obscure follicle cell impressions (Fig. 1F) *S. wahkeena*
 Apex of subgenital plate rounded or acute, broadly triangulate (Fig. 2A); egg elongate with distinct follicle cell impressions (Fig. 1A) *S. bradleyi*

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